

# Inspection of unusual Pipe Types with Eddy Current Technologies

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# Innospection – Company Introduction



**Expertise :** *Providing Advanced Electromagnetic Inspection Services & Application Solutions*

**Offices:** *Aberdeen (Head Office) , Rugby, Abu Dhabi, Al-Khobar, Perth, Melbourne, Stutensee (R&D – Germany)*

**Activities :** *Tube Inspection (HE & Boiler)*  
*Pipeline Inspection*  
*Storage Tank Inspection*  
*Pressure Vessel Inspection*  
*Subsea Inspection*

- *Caissons*
- *Risers*
- *Structural Legs*

*Flexible Riser Inspection*  
*Advanced crack detection*  
*R&D for Inspection Solutions*



# Inspection of “regular” pipe



- *Regular pipe type is*
  - *Ferritic steel*
  - *No or thin coating*
  - *One type of steel material*
  - *Single layer*
- *Existing pigging inspection technologies*
  - *Ultrasonic Pulse Echo methods*
  - *Magnetic Flux leakage methods*

# What pipe is typical and what is unusual?



*Examples of inspection tasks, for which regular inspection technologies fail:*

- *Pipe with coating thickness in the range of 40 mm*
- *High steel wall thickness (MFL fails)*
- *Pipe clad with a different metallic layer (internal or external)*
- *Non typical materials, such as Stainless Steel or Duplex*
- *Non-solid pipe material made from several layers of different material like flexible pipe*
- *Operational restricted : Riser Sections – particular Gas Risers*

# What can eddy current do?



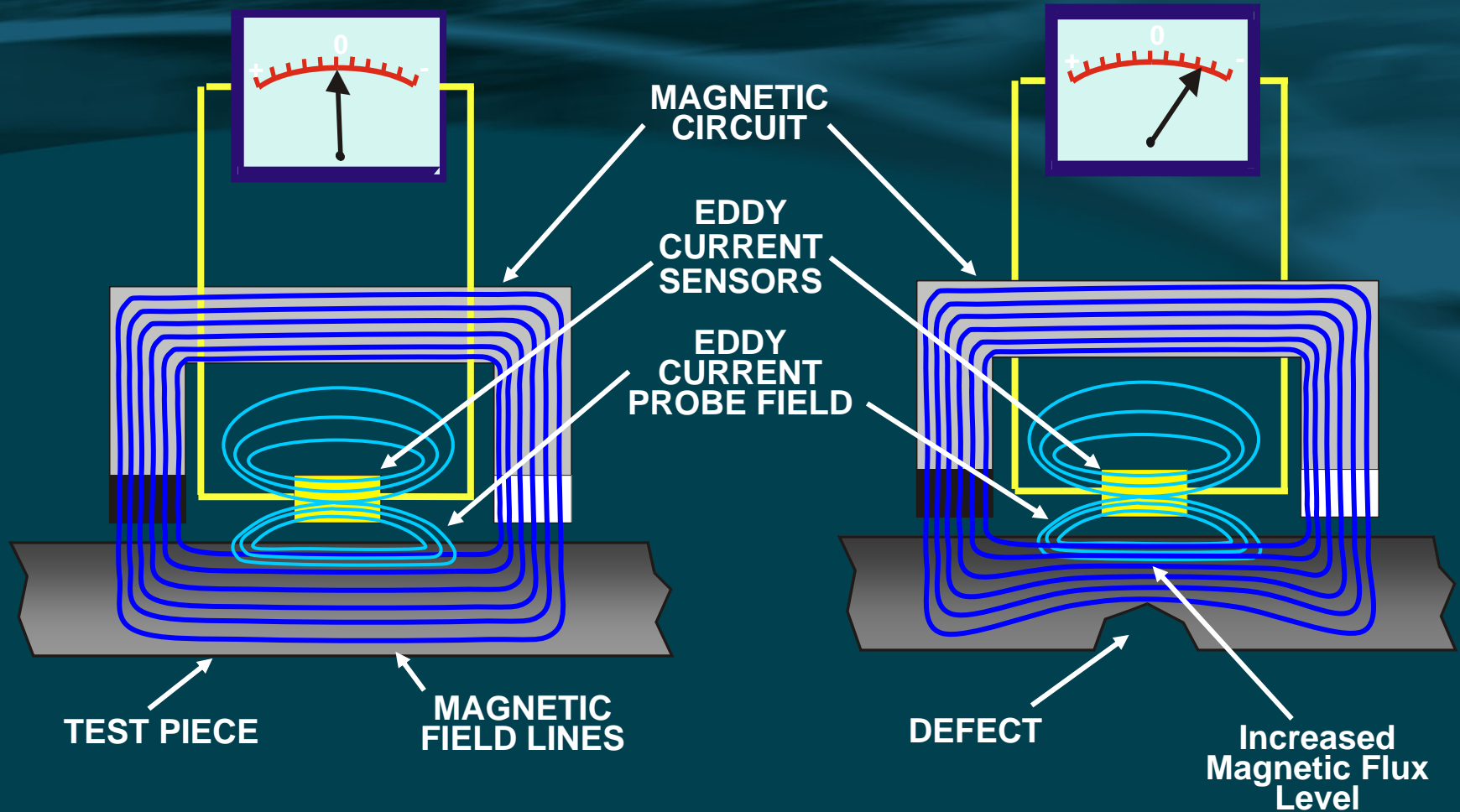
## *“Traditional” Eddy current*

- *Inspection of the near side only, i.e. for cracking or as a lift-off measure*
- *Traditional application in weld inspection, heat exchanger tube inspection, material sorting etc.*
- *Cannot inspect the volume of thick ferritic steel structures*

## *Alterations of classic eddy current to circumvent these Problems*

- *Magnetically biased Eddy Current (SLOFEC™)*
- *Pulsed Eddy Current (PEC)*
- *Remote Field Eddy Current (RFET)*

# Magnetically Biased Eddy Current (SLOFEC™)



# Magnetically Biased Eddy Current (SLOFEC™) typical applications



## Storage Tank Scanning Capabilities

Wall Thickness range : up to 30mm  
Inspecting trough coating : up to 10mm



## Pipe & Vessel Scanning Capabilities

Wall Thickness range : up to 30mm  
Inspecting trough coating : up to 7mm

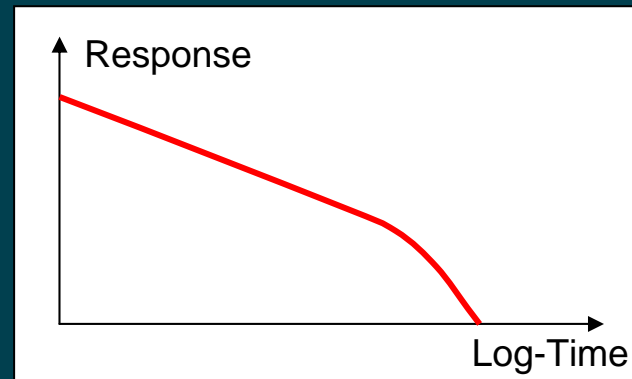
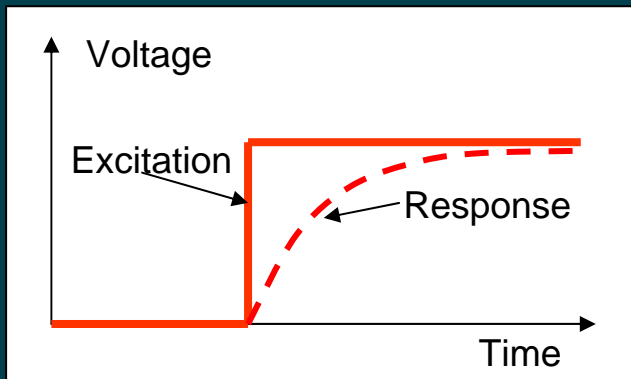


## Riser & Caisson Scanning Capabilities

Wall Thickness range : up to 30mm  
Inspecting trough coating : up to 15mm

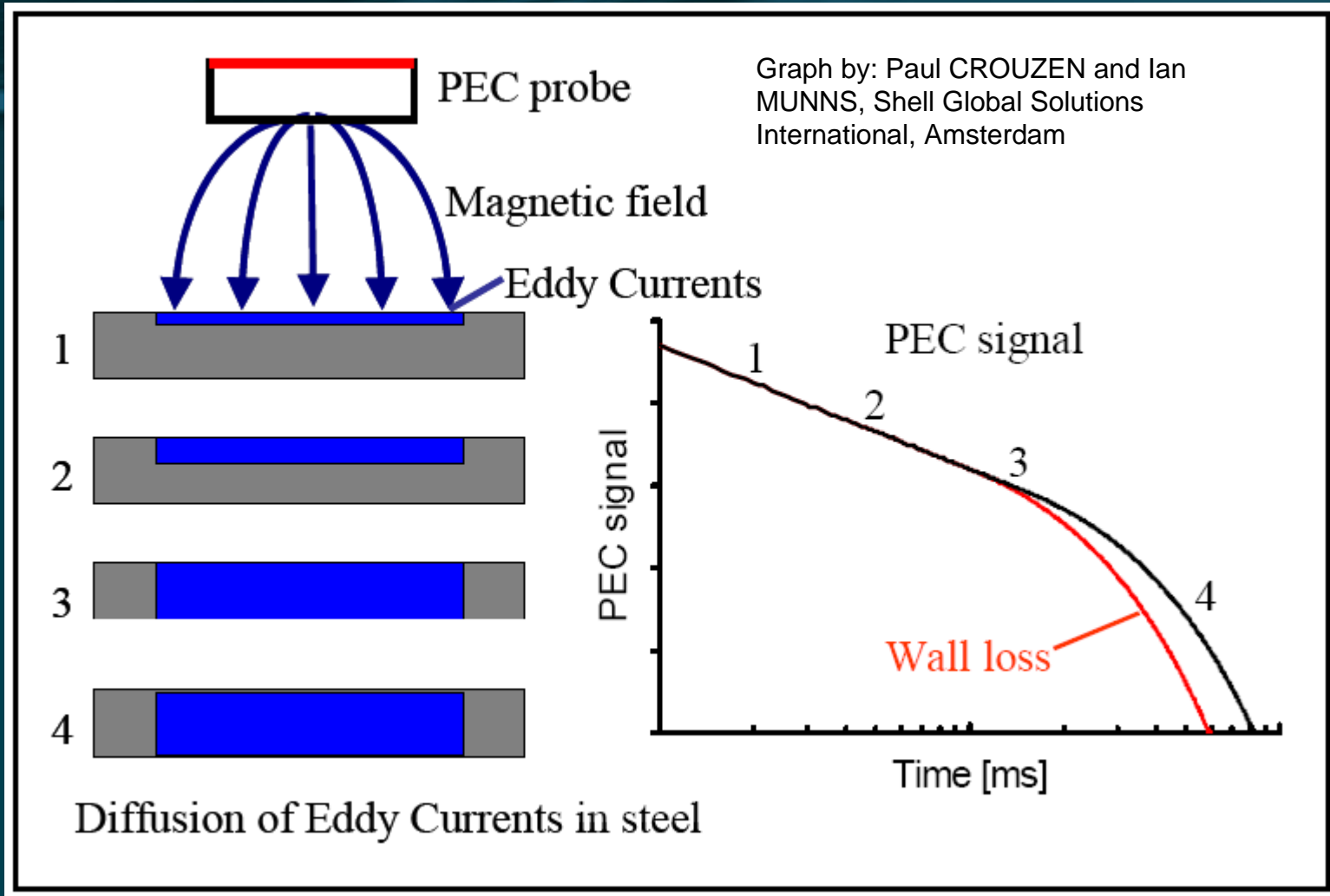
# The idea of pulsed eddy current

- *The higher the frequency the lower the penetration depth*
- *High frequency response probes the surface (sensitive to lift-off)*
- *Low frequency response probes the interior (wall thickness)*
- *A pulse contains a large frequency spectrum*
- *The response can be split up into different frequency content*





# Pulsed Eddy Current Testing



# Remote Field Eddy Current

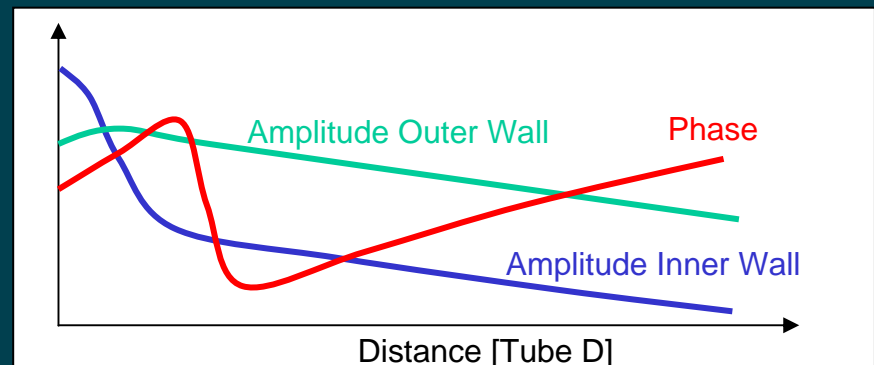
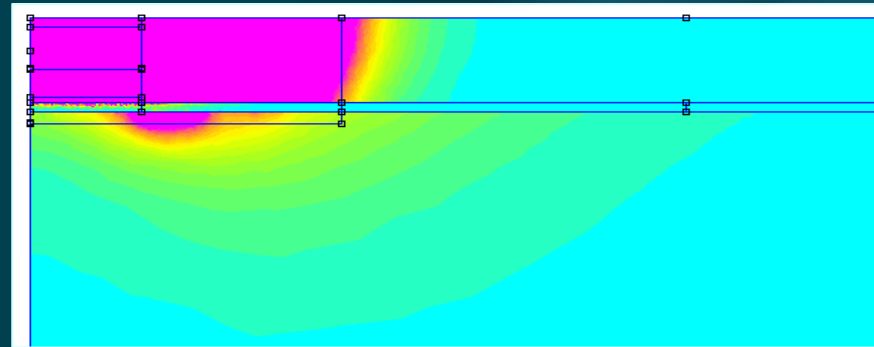
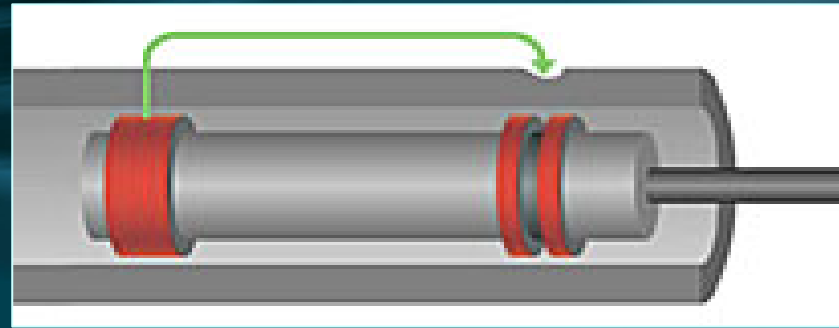


*Current Application mainly for Testing of small tubing like heat exchanger tubes*

- *Due to low frequency inspection not possible at high speeds*
- *Sensitive to wall thickness thinning*
- *Evaluation of the phase of the signal*
- *Rather insensitive to lift-off*

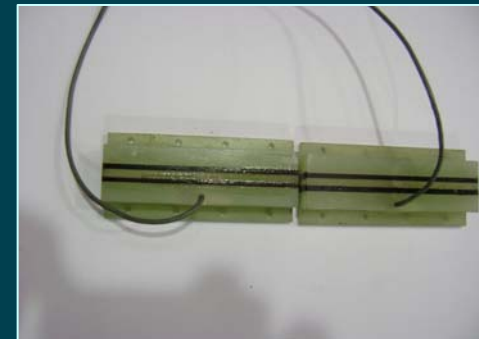
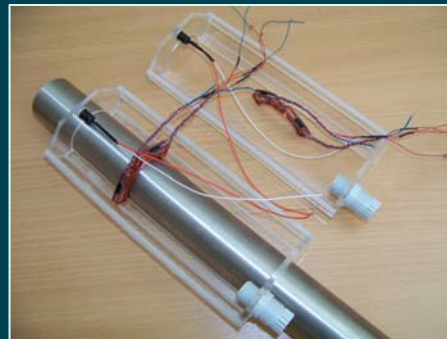
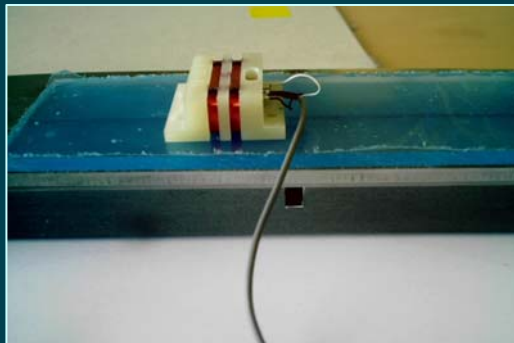
# Principle of Remote Field Eddy Current

- *Exciter Coil generates magnetic field at low frequencies*
- *Pick-up coil is placed sufficiently far away*
- *Does not pick up directly coupled signal*
- *Signal is coupled through pipe wall and thus depends on wall thickness*
- *Phase shift directly converted to wall loss*
- *Sensitive to internal and external defects*



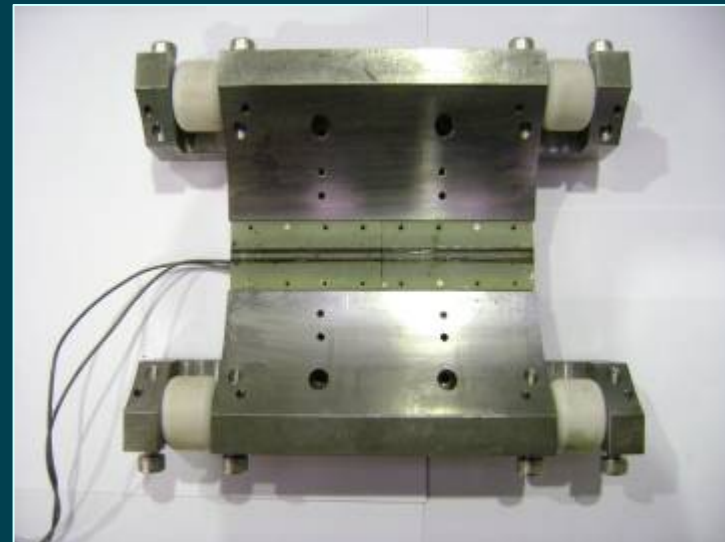
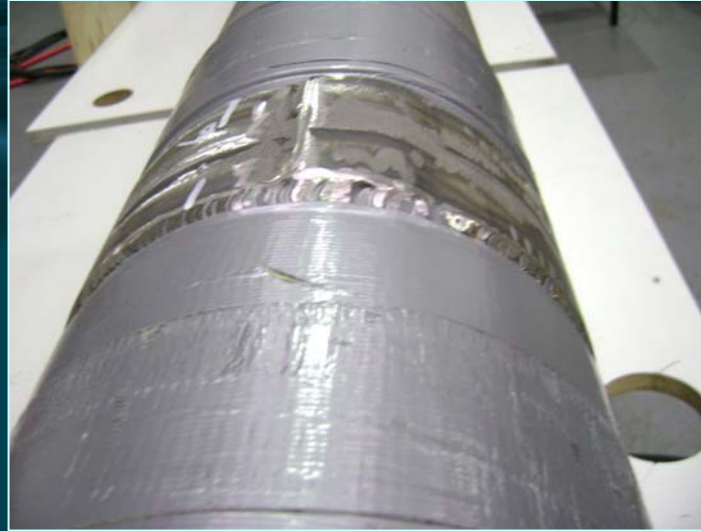
# Coils – Tailor made solutions

- *The key to eddy current testing is the coil.*
- *The Variety of coil types is vast*
- *Every coil needs to be tailored to its application*



# Example Solutions

## Monel Cladded Riser Inspection



# Example Solutions

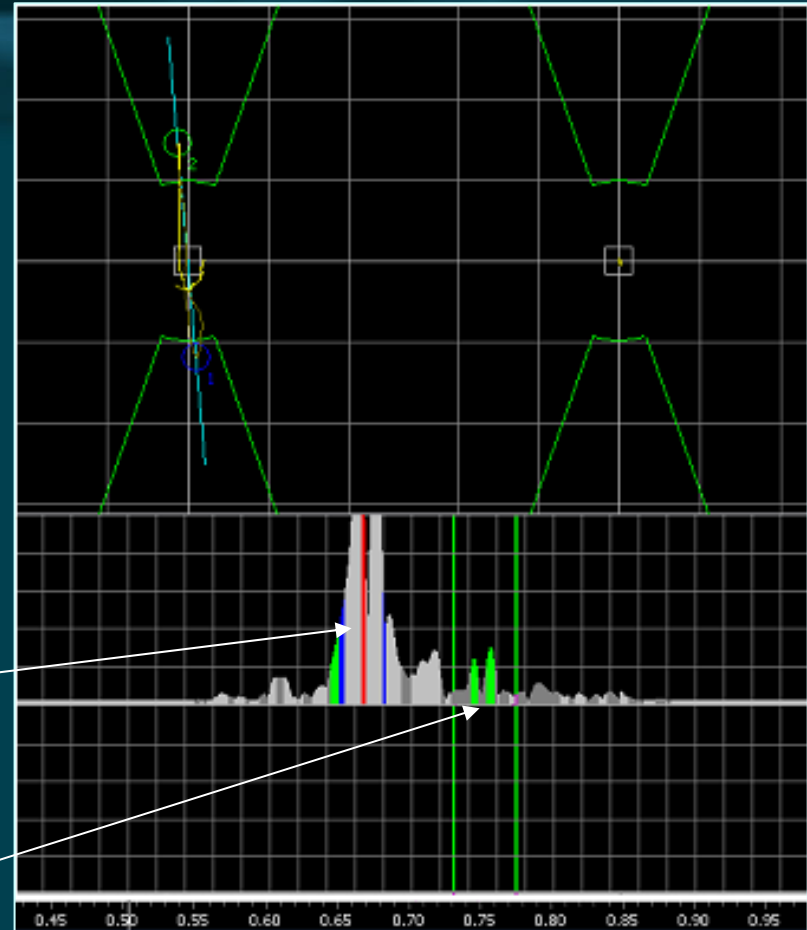
## Monel Cladded Riser Inspection

### Detecting Defects underneath Monel clad welds



Defect before cladding

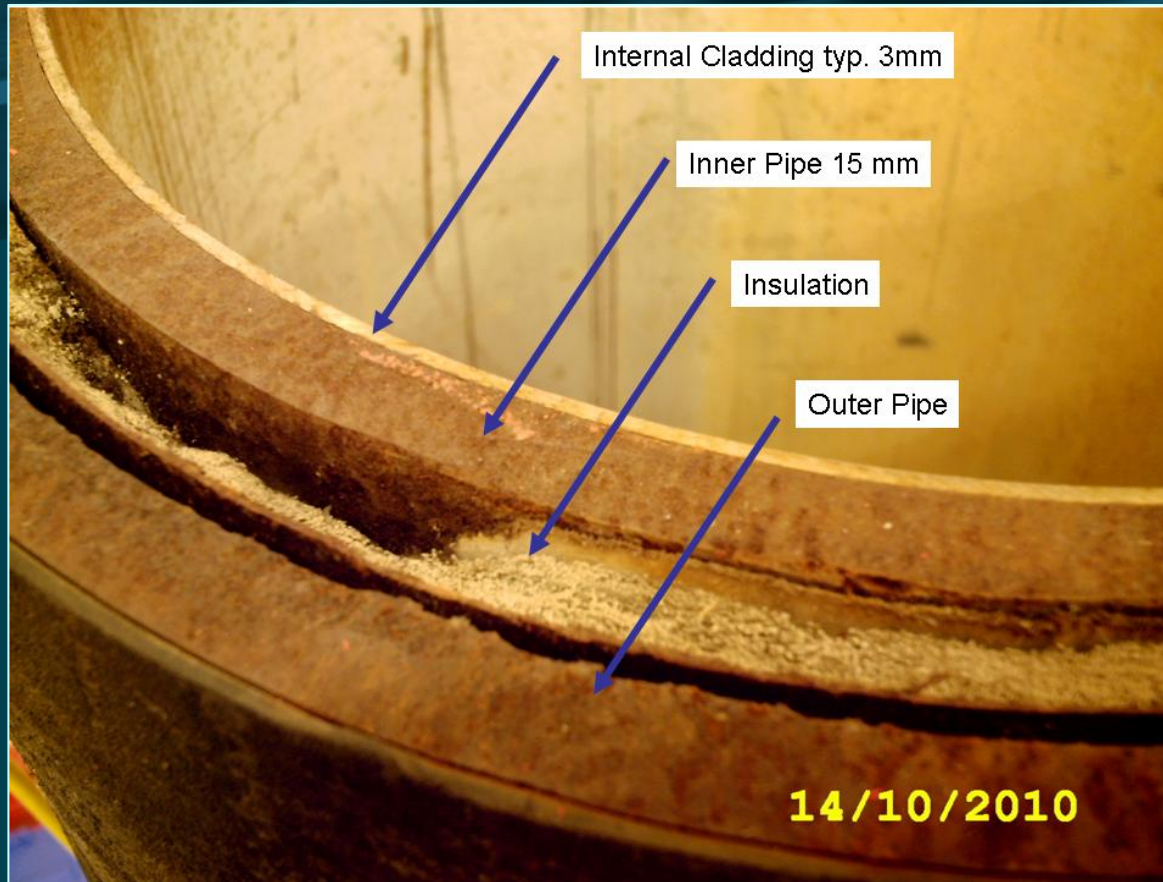
axial weld



defect

# Example Solutions

## Cladded pipe in pipe

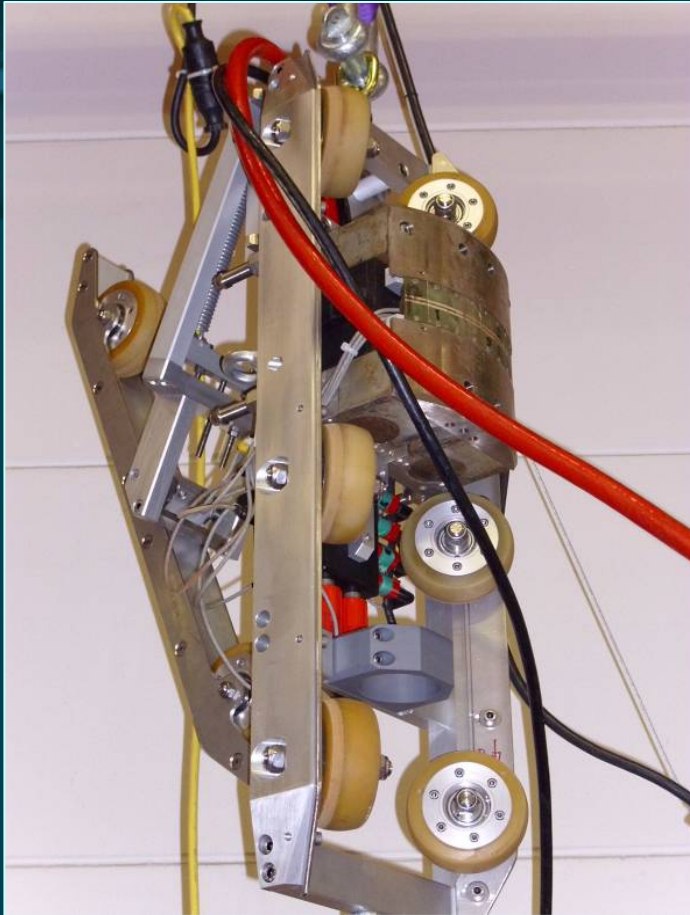


Test pipe with artificial defects

- 3 mm CRA cladding
- 15 mm wall thickness
- Pipe in pipe system

# Example Solutions

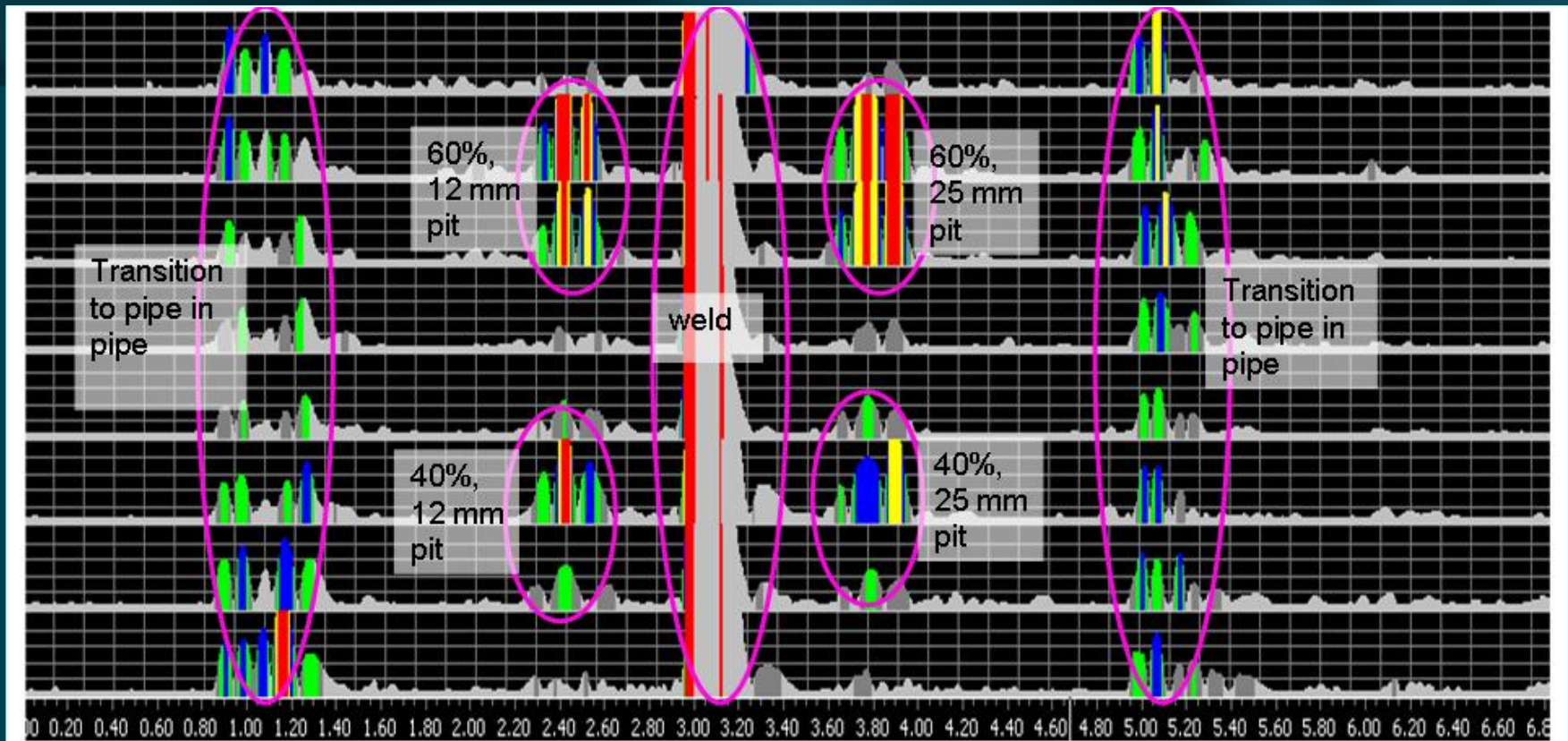
## Cladded pipe in pipe





# Example Solutions

## Cladded pipe in pipe - Signals from test pipe (single pipe section)



# Flexible Riser Pipe

*Flexible riser pipe is pipe made of several layer of steel armour. The armoured layers are wound in a helical form, with different layers wound in different directions*



Picture by NKT Flexibles

## *The problem*

- *Inspect through a thick coating*
- *Inspect all layers, i.e. inspect layers beneath other ferritic conductive layers.*

# Flexible Riser Pipe

## The task - The solution

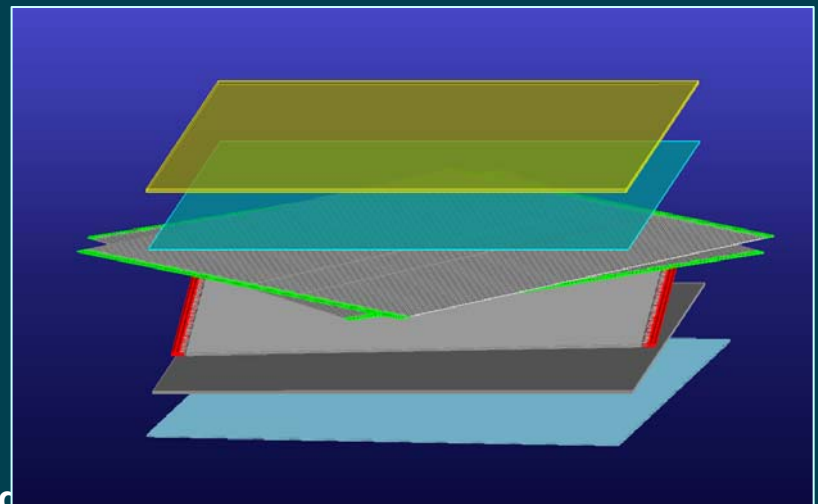
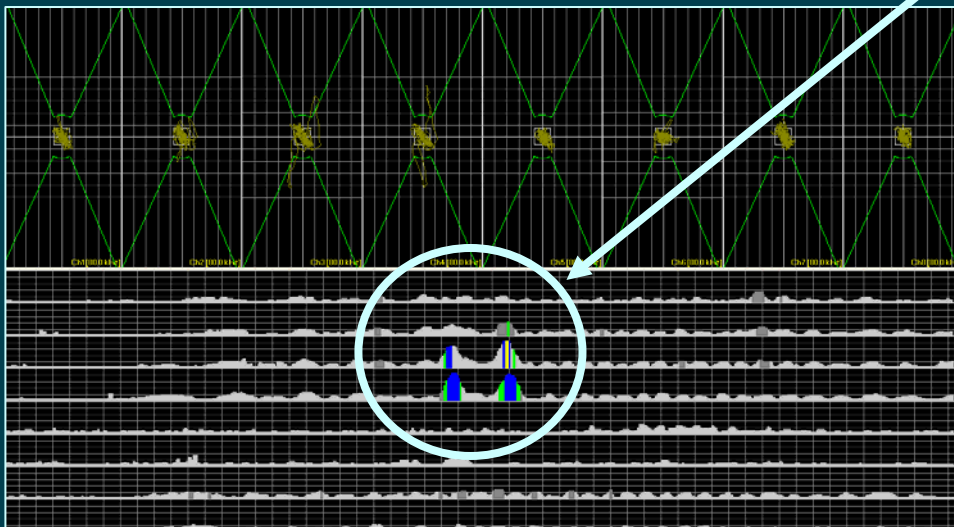


- *Detect defects like snapped wires and metal loss in all layers of the flexible pipe*
- *Need a magnetisation unit that can adapt the magnetisation level*
- *The magnetisation direction needs to be made dependent on the direction of winding*
- *The tool needs to be light enough to be deployed sub-sea*

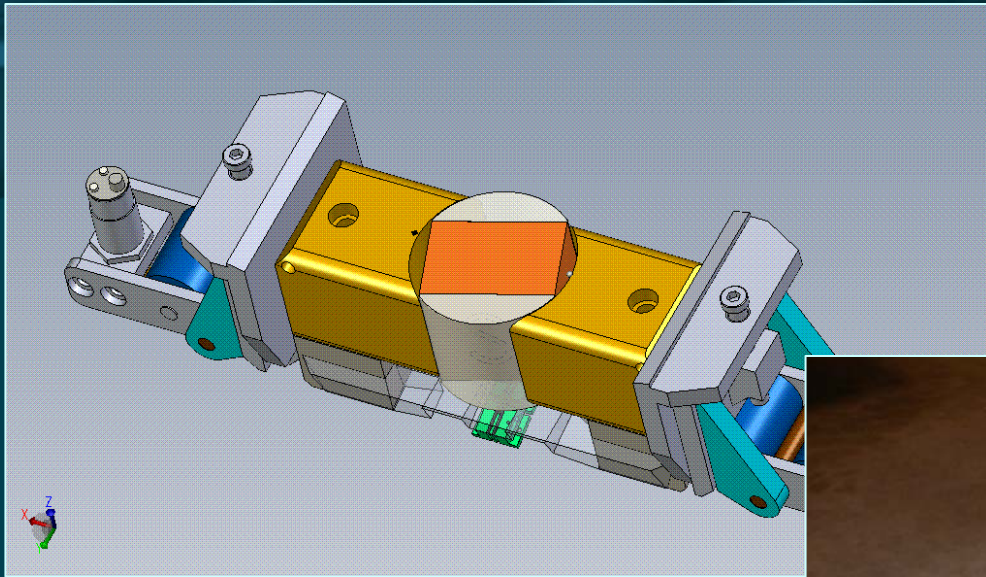
### *First Step*

- *Verify the inspection solution*

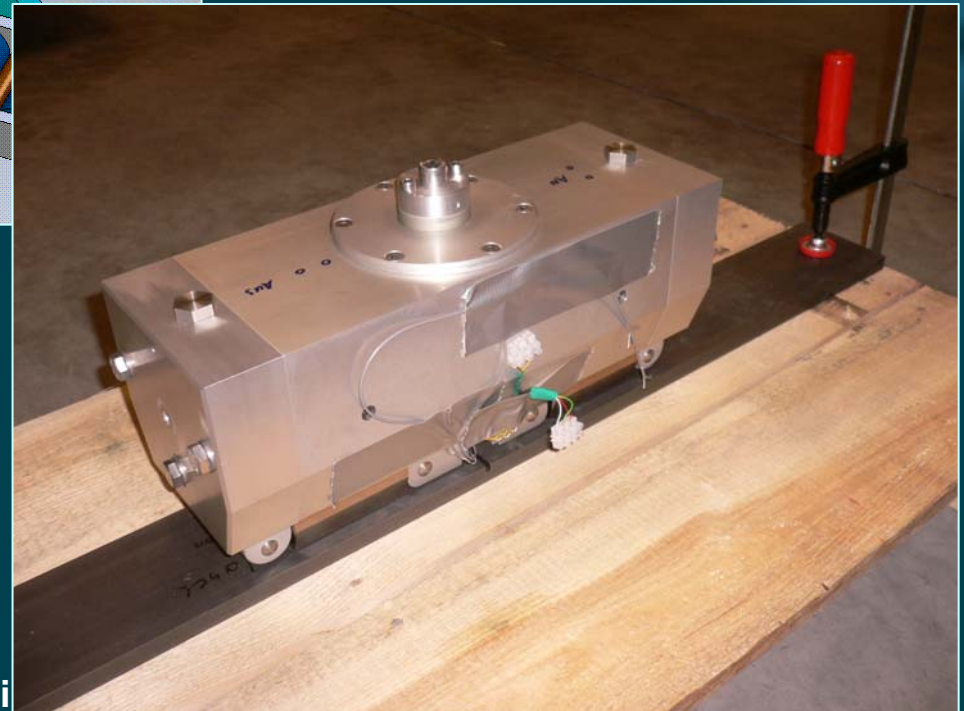
# Flexible Riser Pipe Testing



# Flexible Riser Pipe Development of a suitable magnetisation unit & sensor array unit



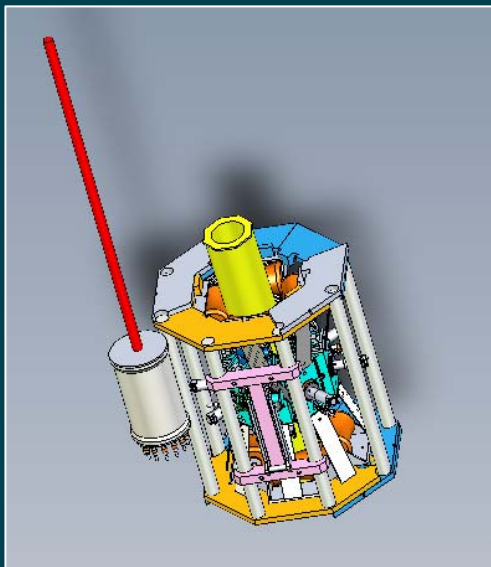
Patented



# Flexible Riser Pipe Operational Arrangements

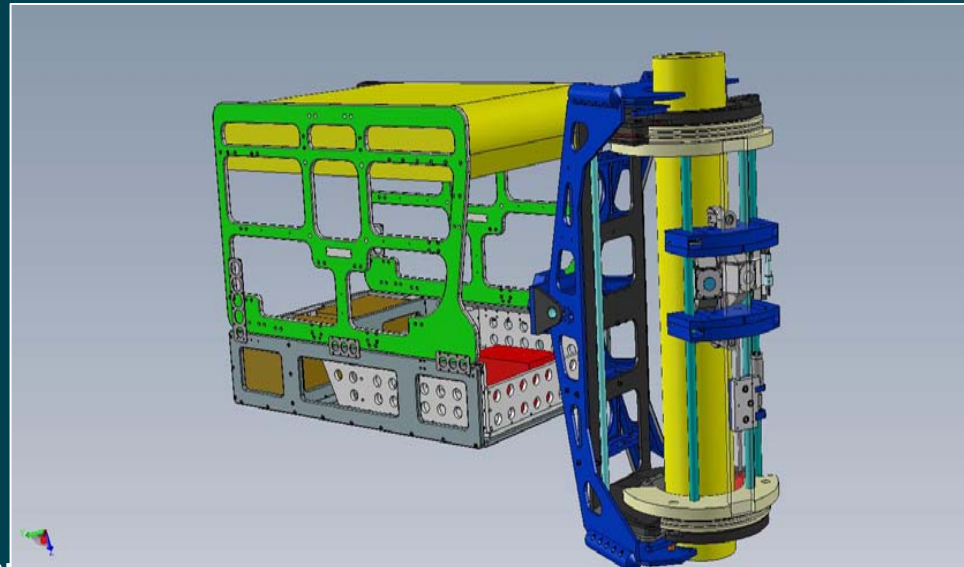
## Full 360 coverage

- Axial movement only
- Higher weight-Requires a work-class ROV for deployment or lowered on steel rope
- Faster scanning. Suitable for long pipe



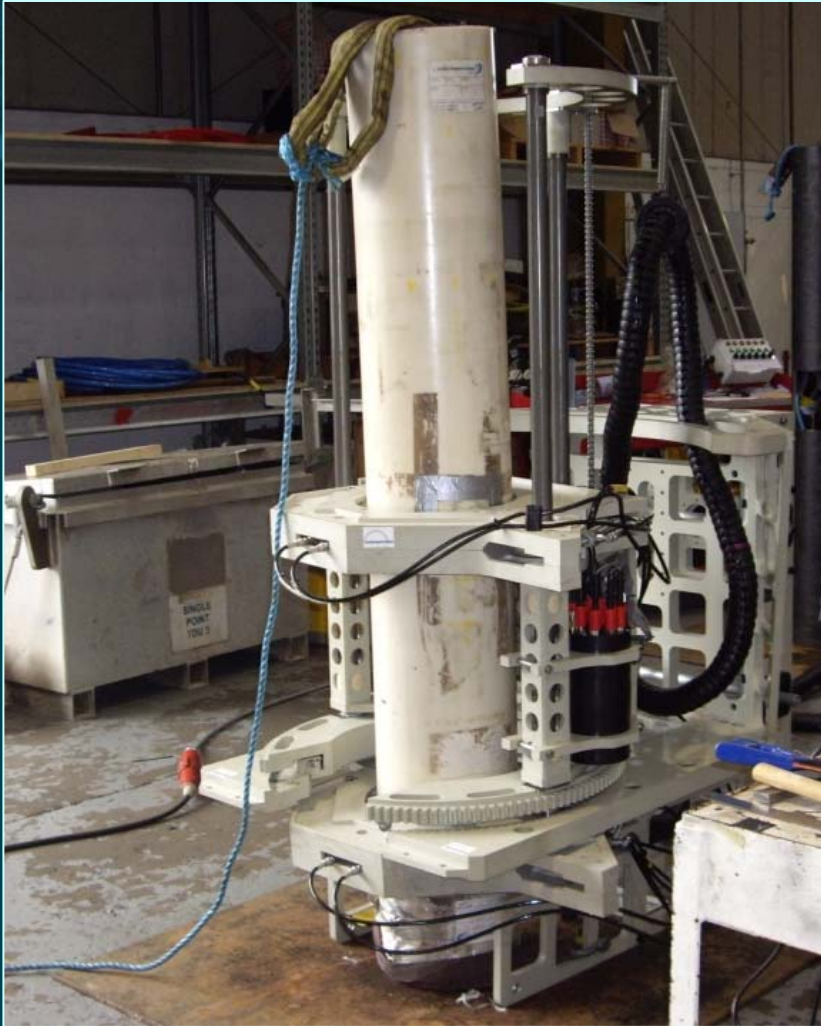
## Partial coverage with circumferential scanning

- Movement in two directions
- Lower weight. Light ROV is sufficient
- Especially for defined areas



# Flexible Riser Pipe

## Lighter Option for ROV deployment



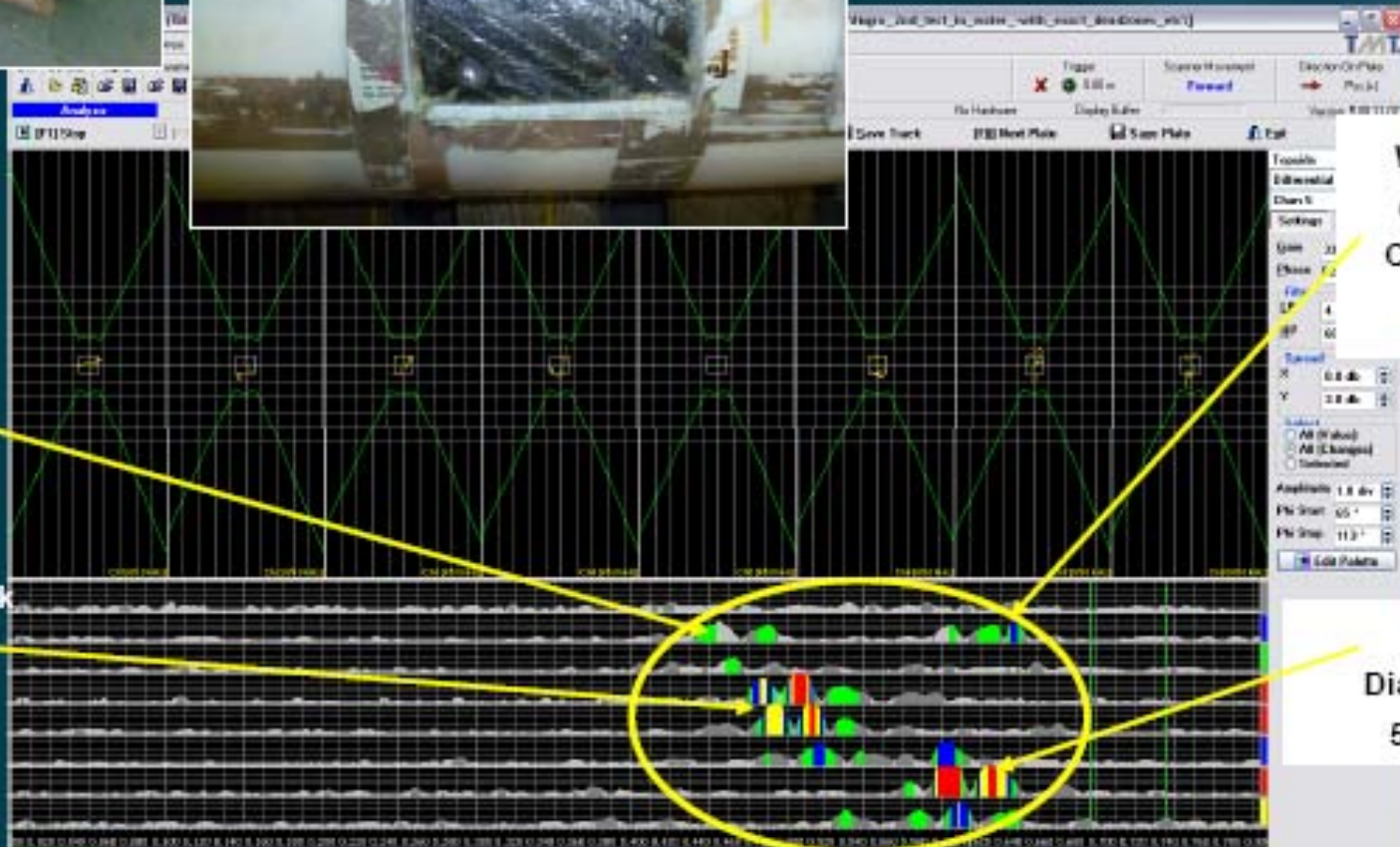
- Scanning up/down in several steps to achieve full coverage
- Light for ROV deployment
- In cooperation with



# Flexible Riser Pipe Test results



## Signal Display Test Defects



With wire  
direction  
Crack type  
1 wire

FBH  
Dia 10mm  
3.0mm

Transverse Crack  
type  
2 wires

FBH  
Dia 10mm  
5.0mm



# Final Word



**Eddy Current technique solutions have the potential to fill pipeline inspection gaps.**